Remarks- Examination Report

1. The drawings were objected to because block elements "112" and "114" required label corrections.

2. Appropriate corrections were made to the Replacement Drawing Sheet included herein.

3. Claims 49, 58, and 71-73 were objected to because of cited informalities.

4. Corrections were made to claims 49, 58, and 71-73, as required by the Examiner to correct the cited informalities.

5. Claim 86 was rejected under 35 U.S.C. 112 as being indefinite for failing to particularly point out and claim the subject matter which applicant regards as the invention. In particular, the phrase "providing for modulating the coded information signals onto at least one of a set of signals" lacks antecedent basis.

6. Claims 33 and 82-97 were rejected under 35 U.S.C. 102(b) as being anticipated by Swanson (U.S. Pat. No. 4,164,714).

7. Applicant submits that the above-recited step of providing for modulating the periodic pulses with at least one information signal to generate a plurality of information-modulated periodic pulses, the information-modulated periodic pulses having at least one of a set of signal characteristics that is a function of the information signal, the set of signal characteristics including amplitude, phase, and frequency, as stated in the amended independent claim 33 (and hence, in the dependent claims 82-97), clearly presents a novel method that the prior-art references neither describe nor anticipate. Thus, the amended independent claim 33, (and hence, the dependent claims 82-97) should be considered patentable under 35 U.S.C. 102.

8. Specifically, the claimed invention **modulates** the pulses such that the modulated pulses bear information in the form of amplitude, phase, and/or frequency of the pulses. The pulses have a frequency spectrum comprising **a plurality of carrier signals having equally spaced frequencies**. Thus, the pulses act as a (multi-)carrier signal. In particular, the claimed invention recites **modulation**, which is defined as "the transmission of a signal by using it to vary a carrier wave; changing the carrier's amplitude or frequency or phase" (www.hyperdictionary.com).

9. By providing modulation of pulses that have a frequency spectrum comprising carrier signals with equally spaced frequencies, the method recited in Claim 33 achieves the following unique consequences:
   a. It spreads each information symbol over multiple carriers, thus providing superior frequency diversity via redundancy.
   b. It provides data-modulated-carriers with orthogonality in time.
   c. It enables multiple information symbols and/or users to share the same frequencies, thus providing combined, and typically contradictory, benefits of frequency diversity and bandwidth efficiency.

   No other prior-art reference provides multicarrier modulation in the form of modulated pulse waveforms. No other prior-art reference maps information symbols to pulse waveforms generated characterized by multiple carriers. No other prior-art reference enables a way for multicarrier-modulated signals to simultaneously employ the same frequencies, yet remain orthogonal in time. Accordingly, no other prior-art reference generates multicarrier signals expressed by pulse waveforms.

10. **None of the prior-art references teach to modulate pulse waveforms having a frequency spectrum comprising a plurality of carrier signals having equally spaced frequencies in a way that produces modulated pulses that are orthogonal in time.**

11. Swanson discloses a single-carrier, rather than a multicarrier output. Although Swanson shows periodic reference pulses, the pulse-modulated outputs (such as

shown by P1, P2, P3, and P4 in FIG. 3) are clearly not periodic. This is due to the fact that Swanson uses a comparator (col. 5, lines 43-48), which produces pulse-modulated outputs characterized by different-width pulses. Thus, the sum signal ΣP_N shown and described in Swanson is not the "information-**modulated** periodic pulses" recited in Claim 33. Rather, the net effect (of the sum signal) is a **sampled** signal

12. Swanson fails to produce an output comprising the input signal modulated onto a multicarrier signal (i.e., a frequency spectrum comprising a plurality of carrier signals having equally spaced frequencies, such as recited in claim 33). Rather, the sum signal has the same general form as the input signal (such as noted in col. 6, lines 21-27).

13. Swanson shows sampling rather than modulation. Sampling is defined as "measurements at regular intervals of the amplitude of a **varying** waveform in order to convert it to digital form," (www.hyperdictionary.com). Swanson shows a varying waveform (FIG. 3) wherein a comparator takes samples of the varying waveform (col. 6, lines 4-12) at regular intervals, thus characterized as "sampling the input signal" (col. 6, lines 18-19).

14. Swanson fails to show modulation. Modulation is defined as "the transmission of a signal by using it to vary a carrier wave; changing the carrier's **amplitude or frequency or phase**" (www.hyperdictionary.com). Rather, than varying a carrier wave (such as the pulse train), Swanson states that the resulting signal is "a pulse train comprised of periodic pulses wherein the duration of the pulses is modulated by the input signal" (col. 6, lines 13-15). Ignoring the fact that the pulses are apparently non-periodic, it is evident that Swanson fails to show modulation because neither the pulse **amplitude, frequency, nor phase** are changed, just the pulse duration. Furthermore, the sum signal is of the "same general form as the input signal" (col. 6, lines 23-24). This result is not indicative of a carrier signal (nor a multicarrier signal) modulated with the input signal, but of a sampled signal.

It will be appreciated therefore that the schema described by the cited art is not the same as that claimed by the present invention. The present claims are therefore novel.

15. The invention should be considered patentable according to MPEP 2116.01 due to the fact that the claim recites the making or using of a non-obvious product as a material function. In particular, the claimed invention produces information-modulated pulses having a frequency spectrum comprising a plurality of carrier signals having equally spaced frequencies. No other prior-art reference teaches generating modulated multicarrier signals in this manner.

16. The invention should be considered patentable over the prior art under U.S.C. 102 due to structural differences between the claimed invention and the prior art, such as described in MPEP 2114. In particular, Swanson shows a comparator (col. 5, lines 43-48), which results in a sampled output signal wherein the samples are related to the frequency of a reference pulse train. Such a comparator (and the corresponding comparator method) is incompatible with generating information-modulated periodic pulses, such as recited in Claim 33.

The Novel Physical Feature of Claim 33 Provides New and Unexpected Results and Hence Should Be Considered Non-obvious, Making Independent Claim 33 (and hence, Dependent Claims 82-97) Patentable Under 35 U.S.C. 103.

17. Specifically, by achieving multicarrier modulation via modulating pulse waveforms, each information symbol is spread over the carriers (thus providing frequency diversity) and the information symbols are mapped to orthogonal pulse waveforms (thus providing optimal bandwidth efficiency and low dynamic range). This enables the following improvements over prior-art multicarrier systems:
    - The multicarrier signals of the present invention can mimic single-carrier signals, such as direct sequence CDMA and time division multiple access signals.
    - The multicarrier system of the present invention can be implemented in current multicarrier systems, including OFDM and MC-CDMA systems.

- The multicarrier signals of the present invention can be received and processed as if they were a single-carrier signal, making the invention backwards compatible with existing single-carrier systems.
- The present invention can provide the enhanced performance (e.g., lower bit error rate, lower susceptibility to interference, improved robustness to multipath) of multi-carrier processing to single-carrier signaling.

Therefore, Applicant submits that the above-recited novel features in the independent claim 33, and hence in the dependent claims 82-97, provide new and unexpected results and therefore should be considered non-obvious, making the claims patentable under 35 U.S.C. 103.

18. None of the prior-art multi-carrier communication systems can provide these New and Unexpected results.

19. Neither Swanson nor any combination of prior-art references can provide these new and unexpected benefits.

20. Because the novel physical features of Applicant's device provide these new and unexpected results over any reference, and the addition of Applicant's device to prior-art multicarrier systems results in a substantial improvement in the performance of these systems, Applicant submits that these new results indicate non-obviousness of the novel physical features and hence, patentability. Accordingly, Applicant respectfully requests reconsideration and allowance of the present application with the above claims.

21. As detailed above, the cited art describes a different type of signal processing (i.e., sampling) to that claimed by the present invention. Although different to the present invention, such signal-processing protocols have use, as is evidenced by the teaching of the prior art. Such use is served by the Swanson protocol for signal sampling and amplification, and there is no teaching in the prior art to change the type of signal-processing protocol provided so as to resemble or reflect that of the present invention.

As there is no motivation to change, no teaching to change, and no description of how any change may be made to produce the multicarrier processing protocol or apparatus disclosed in Applicant's invention, it is submitted that the presently claimed invention is also non-obvious, making the claims patentable under U.S.C. 103.

22. Conclusion

The Applicant submits that every effort has been made to address the Examiner's objection and that the Application is now in condition to proceed to grant.

Drawings: Remarks

A proposed correction to drawing sheet 1 is included, as required by the Examiner.

In particular, the labels —112— and —114— were changed to conform to the original Figure 1.

Claims: Remarks

1. In claim 49, line 1, the term "— claim 30 —" was changed to "— claim 48 —", as required by the Examiner.
2. In claim 58, line 1, "— The —" was inserted before "— multicarrier-signal generator —", as required by the Examiner.
3. In claim 71, line 2, the phrase "— a plurality of —" was replaced with "— the plurality of —", as required by the Examiner.
4. In claim 72, line 2, the phrase "— a plurality of —" was replaced with "— the plurality of —", as required by the Examiner.
5. In claim 73, line 2, the phrase "— a plurality of —" was replaced with "— the plurality of —", as required by the Examiner.
6. In claim 86, lines 3-4, the phrase "— prior to providing for modulating the coded information signals — " was replaced with "— wherein providing for modulating the periodic pulses with at least one information signal comprises providing for modulating the plurality of coded information signals —".
7. In claim 33, line 4, the phrase "— selected to be within at least one predetermined frequency band —" was inserted after "— providing for generating a plurality of periodic pulses wherein the periodic pulses have at least one pulse period and a frequency spectrum comprising a plurality of carrier signals having equally spaced frequencies —" in order to better differentiate the claimed invention from the prior art.